the prescribed dose by 3.4 % due to the change in transmission and scatter condition should be considered. A POM insert for the hollow part of the applicator should be used when the shielding ability is not needed, in order to establish an isotropic dose distribution.

PD-0031

An Octree-based indexing method for Monte Carlo dosimetry in brachytherapy

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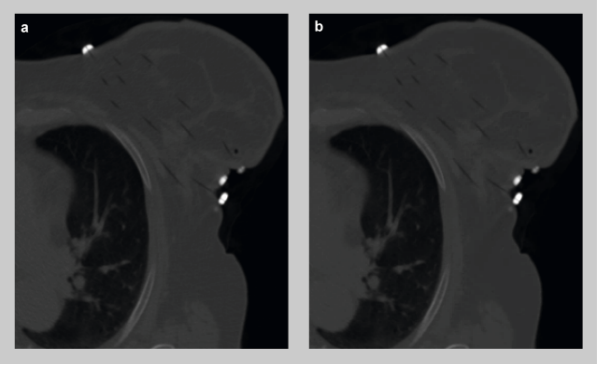
Purpose/Objective: Monte Carlo (MC) simulation in the patient geometry, as the latter is described by pretreatment CT image series, is a candidate dose calculation engine for individualized brachytherapy treatment planning, as well as a source of reference data for the benchmarking of advanced dose calculation algorithms beyond the TG43.
Reducing MC calculation time while preserving results accuracy is beneficial in both contexts, and one of the common practices is the sub-sampling of the original images. This study reports initial results from employing an octree-based voxel compression method in MC dosimetry for brachytherapy patients.
Materials and Methods: An application for preparing MC input files for a general purpose code (MCNP5 v.1.6) from information exported from a treatment planning station in the form of CT dicom images, RTDOSE, RTSTRUCT and RTPLAN has been developed.
An octree-based indexing method was considered for importing the patient geometry as an alternative to standard approaches such as the lattice feature of the MCNP geometric package.
According to this method a compression is achieved by combining voxels into octants provided that their difference in density is lower than a predefined density gradient threshold. The advantage of this method is that the highest resolution is maintained only in heterogeneous regions where high-density gradients are met.
A representative breast ^{192}Ir HDR patient CT image series (512x512x32) was selected, and the density of each voxel was obtained by applying the CT HU calibration. After voxel compression, the patient geometry can be imported into the MCNP code by defining the planes describing the octants in the octree based method.
Results: Different density gradient thresholds were used for the representative breast case studied. Thresholds of 0.045 g/cm^3, 0.067 g/cm^3 and 0.1 g/cm^3 result to voxel number compressions of 70%, 80% and 88% relative to the original image series.
As shown by the comparison of the image of an indicative plane in the original (a) and compressed (b) geometry for the 0.1 g/cm^3 threshold, some information loss occurs along with CT noise filtering for density gradient below the threshold, and heterogeneity interfaces are correctly delineated.



Conclusions: A robust octree-based indexing has been developed and proved to be an efficient method for sub-sampling image data required for patient specific MC dosimetry in brachytherapy in agreement with previous findings in the literature.
The dosimetric accuracy versus the calculation time efficiency achieved for different density gradient thresholds, as well as the comparison to alternative MCNP strategies (i.e.lattice feature employing the speed tally option) is work in progress
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PD-0032

Impact of heterogeneities in a gynecological cancer treatment using a HDR Ir-192 source

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Purpose/Objective: Modern treatment planning systems (TPS) for brachytherapy are now available that are based on model-based dose calculation algorithms (MBDCA). They enable heterogeneity corrections which are needed to replace the TG43 water dose formalism with a more accurate approach. With the aim of evaluating differences between two TPS regarding the impact of heterogeneities such as applicators and tissues in a clinical case, five gynecological brachytherapy treatment plans were compared.
Materials and Methods: The treatment planning was done using a commercial TPS (BrachyVision™(BV), Varian). The plan was created for a Gammamed Plus source, 17 dwell positions and a prescribed dose of 7.5 Gy at 0.5 cm from the applicator, which consists of a hollow plastic cylinder with external diameter of 3.5 cm and 0.4 cm wall thickness. The applicator was contoured using CT images of the applicator only (1mm^3 voxel size) and then inserted in a real patient image using rigid image registration (Fig. 1.a and 1.b) considering its real composition. A water-based applicator was used to study tissue effect in a separate calculation. BV was used to obtain $D_{w,w}$ (TG43) and also $D_{w,m}$ through a grid based Boltzmann solver, ACUROS™ (AC), which can handle heterogeneities. The dose distributions were then compared to results ($D_{w,m}$) obtained with a Monte Carlo (MC) code, MCNP5, with tissue compositions provided by AC and the applicator defined through an analytical geometry. Simulation uncertainty (1σ) was lower than 1% inside the 50% isodose region.
Results: AC and MC results compared with TG43 presented differences up to 17% with mean difference inside the 100% isodose region of 5.2 ±1.2% and 5.3±1.5% (Fig. 1.c), respectively. These differences are mainly due to the air gap inside the applicator since the mean difference inside the 100% isodose region when using a homogeneous water applicator is about 1%. AC and MC presented good agreement with differences (Fig. 1.d) lower than 2% and 5% for 79% and 93% of the voxels of the scoring volume (Fig. 1.b), respectively. The mean differences between the $D_{w,m}$ values (AC and MC) were also calculated separately for each tissue (bone, muscle and adipose tissue) and are within 1.0±0.1%, which represents no significant differences due the tissue composition. However, some regions show differences of about 10% (Fig. 1d), especially near the applicator's tip which can be partially attributed to the algorithm employed by AC which solves the Boltzmann equation by discretizing its six variables.

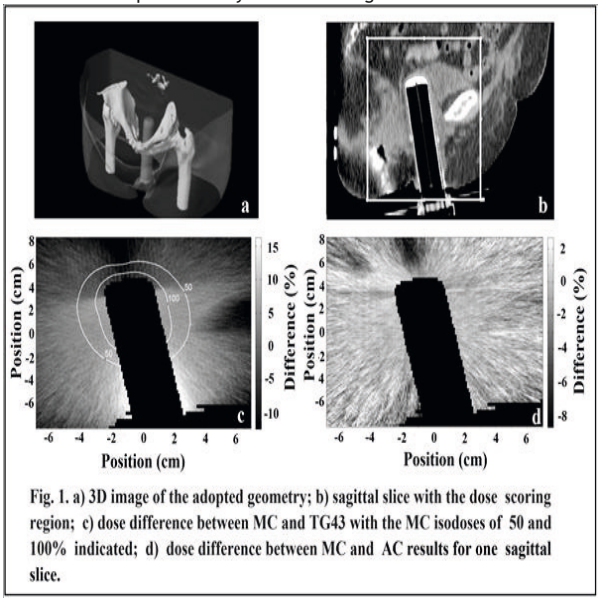

Fig. 1. a) 3D image of the adopted geometry; b) sagittal slice with the dose scoring region; c) dose difference between MC and TG43 with the MC isodoses of 50 and 100% indicated; d) dose difference between MC and AC results for one sagittal slice.

Conclusions: The effect of heterogeneities can be significant due to the applicator considered in this case and it seems to be a relevant aspect due several types of applicators commercially available. AC and MC have shown similar results with no apparent dependence of the tissue, however, dose differences can be higher in some regions which need to be evaluated in more detail.